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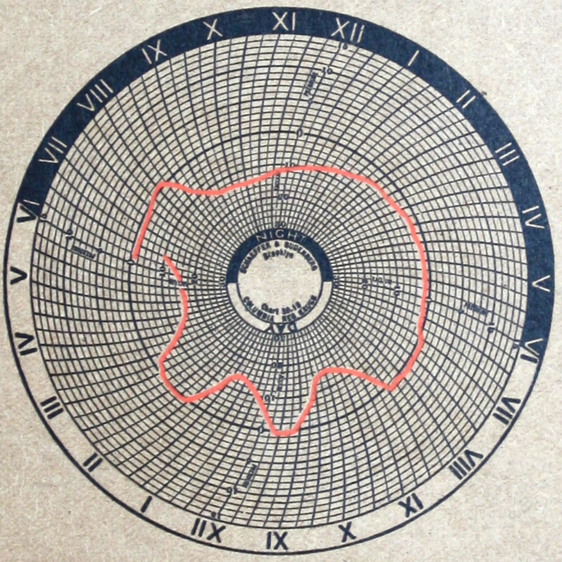
A. I. A. File Number 30c2

ILLINOIS HEATING · SYSTEMS

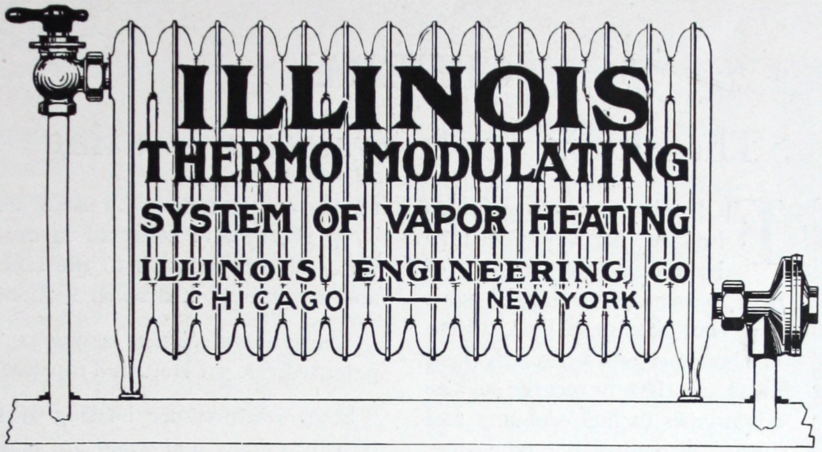


VAPOR DETAILS

BULLETIN 22

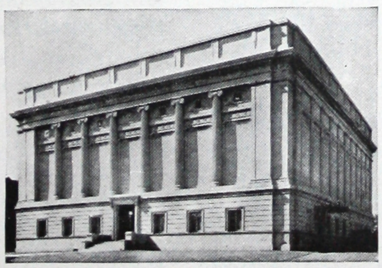
A. I. A. File Number 30c2

International Banking Corporation, Hankow, China



For Apartments, Hospitals, Hotels, Schools, Residences

Vapor System Details
Bulletin Number 22



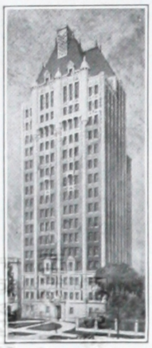
MASONIC TEMPLE—PATERSON, N. J.

ILLINOIS ENGINEERING COMPANY

ROBT. L. GIFFORD. PRES. INCORPORATED 1900
BRANCHES AND REPRESENTATIVES IN 40 CITIES
CHICAGO

GENERAL

The Illinois Vapor System of Heating



1540 Lake Shore Drive Chicago

FOR all types of buildings heated by low-pressure boilers, is the product of over 25 years of specialized work on steam heating. This system has been perfected through these years, so that it secures all the advantages in fuel economy and automatic control, of modulating, atmospheric and vapor systems of low-pressure heating.

The *Illinois System* is the most flexible and the most nearly automatic of any on the market. The *Illinois System* is a true Vapor System with sealed returns, insuring the fuel economy possible from operating at vapor pressure—less than atmospheric pressure—during mild weather.

In the *Illinois System* the radiators and drip points are all equipped with the Illinois Thermo Trap and the Illinois Special Drip Trap (see pages 12-13), which automatically pass water and air to the return mains, but hold steam in the radiators, which, in addition to steam economy, has the added advantage of quickening the steam circulation by keeping steam and pressure out of the returns.

In open return systems, in order to make the system operate automatically at any range of pressure possible in a low-pressure heating plant—in order to put the water of condensation back in the boiler against boiler pressure of over 1 or 2 lbs.—it is necessary to employ a special Return Trap which will equalize the boiler pressure, and at the same time vent any air which the returns carry.

As the boiler pressure is liable to run up to 5 or more pounds at times, even where a damper regulator is installed, the use of a special Return Trap is vital, in order to insure the return of water of condensation to the boiler at all times and prevent cracked boiler sections.

The *Illinois System* employs this improved patented Special Return Trap (see page 15).

Some low-pressure heating systems are open return systems and some are closed return systems; the open return systems have the advantage of quick circulation and positive air discharge at any pressure above atmospheric, but ordinarily do not operate as vapor systems—below atmospheric pressure—and will not put the condensation back in the boiler at all pressures.

The closed return systems permit the water to return to the boiler, but the circulation is impeded by the pressure carried in the returns.

The Illinois Return Trap operates so as to make the *Illinois System* alternately both an open and closed return system, thus combining all the essential and beneficial features of both types of system. The Illinois Thermo Valves on all radiators permit the air to escape from radiator through large openings ($\frac{1}{4}''$ minimum) not through pin holes as in ordinary radiator air valves, thus securing almost instantaneous circulation of steam and saving the fuel energy necessary to force the air out through pin holes.

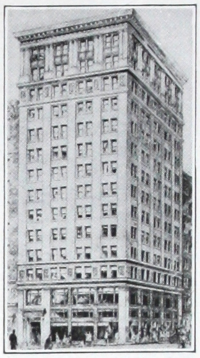
This fact alone would justify the use of the *Illinois System* over ordinary steam or hot water plants, as it can be operated to quickly respond to sudden changes in outside temperature. With this system it is possible to get either the positive heat of a steam system in severe weather, or the milder heat of a hot water plant in moderate weather, without the additional radiation necessary in every hot water plant, and this change in

pressure can be effected in a few minutes simply by firing the boiler.

The so-called true Vapor Systems on the market are always operated at vapor or low pressures, hence it is necessary to install at least 25% more radiation than for ordinary steam jobs, in order to get sufficient heat in severe weather. The *Illinois System* only requires standard steam radiation, the same as ordinary steam heating plants; because, owing to its flexibility and adaptability, it operates on steam pressure in severe weather as readily as it operates on vapor in mild weather.

Heat control or temperature regulation for the building is, therefore, secured by firing the boiler in accordance with the demands of the weather, and where individual control for different rooms is desired it is secured by the Illinois Modulating Valves, which supply steam to the radiators (see page 14). A slight turn of the handle regulates the amount of steam admitted to the radiator, thus easily putting the temperature of the room within the control of the occupant. A dial indicates the position of the valve.

Vapor heating is secured by our *Illinois System* because the Illinois Heat Retainor—Browne Patent—(see pages 10-11), while allowing the air to vent at only 1/3 of an *ounce* pressure, absolutely prevents its drawing back into the heating system, therefore, as the radiators cool off, the resulting vacuum in the radiators pulls vapor out of the boiler (and not air from the room), so that our System will deliver all the heat in the boiler down to 160° to 170°, depending on the tightness of the piping installation. This feature gives wonderful fuel economy as compared with ordinary heating plants, where the heat below 212° is wasted in the boiler room, and none of it delivered to the rooms upstairs.



No. 1 State Street
Boston

No air valves are used on radiators, thus avoiding the drip or leak and odor from same. *Illinois Systems* are noiseless because perfect drainage is provided for water of condensation.

While the system is ordinarily operated at or below atmospheric pressure, our automatic devices control the operation under any condition of pressure possible in a low-pressure steam plant —from 10 pounds pressure to 25 inches of vacuum.

The Illinois Vapor System is, therefore, the system to install for discriminating and exacting users for all high-grade buildings heated from low-pressure boilers.

Apartment, 18th and Park Ave., East Orange
Edward Warren, Architect

Leland Hotel, Chicago
Dubin & Eisenberg, Architects

True Vapor Heat

Abercrombie and Fitch Bldg., New York

VAPOR Heating, as the term is broadly applied today refers to a two-pipe gravity return system of steam circulation in which provision is made to retard, or prevent escape of steam from the radiator into the return main, and in which the air from the system, as well as the water of condensation, is carried back to a central point. The air is liberated at this point and provision is made for returning the water of condensation to the boiler. These are really good gravity steam systems, while a true Vapor System goes futher, and secures the operation of the system for hours at a time on *Vapor*—or less than atmospheric pressure steam.

There are four essential features to true Vapor Systems in addition to the boiler, piping and radiation. A majority of so-called Vapor Systems have only the first and second elements, some few have also the third. These features are:

First: A Supply Valve which for convenience is generally of the quick-opening type, and which should be packless, or self-packing, so that there will be no leakage of steam when the System is under pressure, or back flow of air through the valve packing, when the System is operated below atmospheric pressure.

Second: A Thermo Trap on every radiator return to permit passage of air and water into the return, and positively prevent steam from passing into the return piping.

Third: A positive Return Trap, capable of returning the water of condensation to the boiler at all pressures up to the working limit of the boiler.

Fourth: An Air Liberating and Seal Device which will permit air to pass from the system without appreciable back pressure and which will absolutely prevent the return of liberated air.

During the many years in which the Illinois Engineering Company has made a special study of Vapor Heating we have always taken the initiative in the development and refinement of all of the above essential features of a Vapor System. We are designers and builders of the original vertical seat Thermo Trap for radiators. This trap is today recognized as the standard and has been adopted by the leading Industries because of its simplicity, sensitiveness and self-flushing features.

We are Pioneers in the development of the positive Return Trap for Vapor Heating Systems and have insisted for many years that the only successful type of Vapor System was one in which the return main from the radiators was freely vented to atmosphere at all times and that water of condensation should be returned to the boiler through an Equalizing Return Trap and not from a return main under pressure. This claim is today conceded by all Engineers, and all modern Vapor System Designers are now following this precedent.

The fourth element, *the Air Liberating and Seal Device*, while admittedly valuable, has presented difficulties both in satisfactory design, and in its effect upon the whole system, unless the system was properly designed for circulation below atmospheric pressure. These difficulties have led many Manufacturers to abandon this essential feature, and to omit the mention of Vapor in their literature. We have always maintained that a positive vent check device which permits operation at less than atmospheric pressure for hours at a time,

was the element which differentiated a Vapor System from a gravity system.

While the first and second elements insure good circulation and some fuel saving—perhaps ten per cent over a gravity job—and the third element safeguards the system by preventing danger of cracked boiler sections through properly returning the water to the boiler at all pressures, it is the *fourth element*,—a successful *Air Liberating and Seal Device*,—which makes possible a further fuel saving of 20% to 25%, and gives the benefit of the mild, healthful heat of Vapor at less than atmospheric steam pressure and temperature—the True Vapor System.

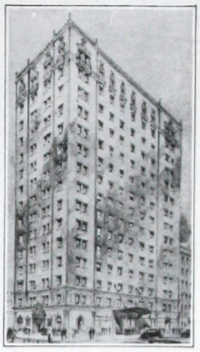
We have consistently worked towards this goal for over fifteen years, during which time we have used mercury seals, diaphragm valves, ball checks, etc., which operate satisfactorily for a time, and perhaps require no more attention than the average mechanical equipment, but which being frequently installed where not readily accessible, and not being cleaned or adjusted, soon allow the Vapor System to deteriorate into a gravity system.

The *Illinois Heat Retainor*—Browne Patent No. 1,450,245, operating on a new principle, fulfills the requirements for a permanent Air Liberating and Seal Trap which will operate positively for years without adjustment. It vents air at about 1/8-ounce pressure, and positively prevents the return of the air. This improved device has been used on Illinois Vapor Systems for three winters and has fulfilled every requirement. It is with great satisfaction that we offer this improved device.

Because of absurd claims for economies made for Systems where the system could only operate at or above atmospheric pressure and because of failure of such systems to fulfill these claims, many Heating Engineers and the public in general have failed to realize the wonderful economies which are possible and which are actually being obtained in Illinois Heating System cooperating in conjunction with the Illinois Heat Retainor.

To best present the basis on which our claims for economies are made, we will restate a few of the fundamentals of physics:

First: The term "Atmospheric Pressure" used to indicate the pressure due to the weight with which the air above the earth presses on the earth surface, and is normally 14.7 pounds per square inch at sea level.



East Gate Hotel
Chicago

Second: Pressures at, or below atmosphere are measured by the use of a mercurial barometer, and the atmospheric pressure of 14.7 pounds will support or balance a column of mercury 29.92 inches high. In ordinary practice these figures are taken as 30 inches of mercury and 15 pounds pressure for convenience, or two inches of vacuum equal to a reduction of 1 pound pressure.

Pressures above zero are pressures in pounds, reduced or negative pressures below zero are termed *vacuum* or *vapor* in inches. A Heating System must be able to operate under Vacuum or Vapor conditions, in order to justify the name—"Vapor System."

Third: In scientific practice, pressures are often spoken of as "Absolute," meaning pressures above a perfect vacuum, and on this basis the atmospheric pressure is 14.7 pounds absolute, at sea level. On a standard gauge dial, this atmospheric pressure is indicated by the zero reading. Pressures above atmosphere are read in pounds, and for the sake of convenience each pound is divided into ounces. Pressures below atmosphere are read in inches of mercury and termed inches of vacuum, and zero pressure absolute is thirty inches of mercury. From the above it will also be clear that a pressure of one pound on the gauge is a pressure of nearly 16 pounds absolute.

3314 Sheridan Drive, Chicago

Fourth: The temperature at which water boils at atmospheric pressure is 212° Fahr. and steam will be generated at this temperature. When water is boiling under atmospheric pressure, if the pressure on the surface of the water is increased the boiling point is raised, and as the pressure is decreased the boiling point similarly is lowered. A Steam Table showing the relation between boiling point of water and the absolute pressure and atmospheric pressure is shown on page 8.

With a clear understanding of the above, the operation of a Heating System is readily explained. The water in the heating boiler will boil at 212°, when the System is being started up at atmospheric pressure and the steam generated will tend to fill the piping and radiation. As the system is already entirely filled with air, and as the air and steam will not mix, the air will be compressed by the steam which is tending to fill the same space, and this compression continues until sufficient pressure is created to expel the air through the air valves, or through the Eliminator. This may occur at ½ pound, 1 pound or 5 pounds, depending on design of the System.

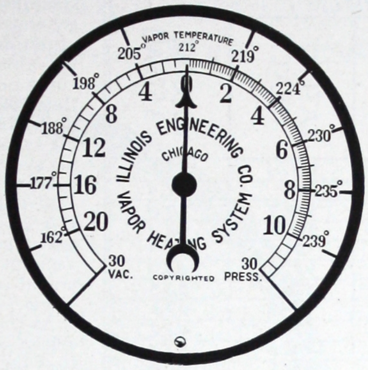
The increase of pressure in the system necessary to expel the air also raises the point at which the water will boil, so that it is necessary to heat the water to a higher temperature in order to generate steam under that pressure. This pressure also must be maintained until all air is expelled and the system filled with steam, and coal must be fired to the boiler and consumed at a rate fast enough to maintain this pressure. If the fire is checked, due to the closing of the damper, the system begins to cool off as sufficient steam is not then being generated to fill the system, and unless the return of air is successfully prevented, the cool air of the building is drawn back into the piping and radiators to fill the void created by the condensing of steam. This explains why systems often "go cold" with apparently a good fire in the boiler, which in reality is not hot enough to generate steam at the pressure required to expel the air from the system.

However, if all air is expelled and the air thus expelled is prevented from returning to the Heating System when the fire is checked, the condensing of the steam in the radiators will create a vacuum condition or a pressure below atmosphere in the entire heating system. This lowering of pressure also lowers the boiling point of water, and the water in the boiler continues to give off steam vapor which will circulate through the Heating System, thus conserving heat which otherwise would be lost in the basement.

From the Steam Table given, you will note that if this vacuum condition should equal ten (10) inches of mercury on the gauge, the boiling point of water, under these conditions, is 192° F. as compared with 212° F. for zero pressure, or 239° F. for 10 pounds gauge pressure.

Another fact shown by the tables should also be recognized and that is, that the volume of steam which is given off by one pound of water, when evaporated will vary with the pressure just as the temperature at which the steam is generated varies. When the boiler pressure increases, more pounds of water in the form of steam are compressed in the Heating System and radiators, so not only is the temperature of the radiators higher, but there is more heat available because there is more steam actually in the radiator.

Conversely, when the pressure of the steam inside the Heating System falls below atmosphere the temperature of the steam is reduced and there is also a smaller weight of steam in every radiator, because the volume of a pound of steam, under the reduced pressure, has increased, as given in the table. This expansion of the steam quickens its circulation also. The radiators are, therefore, at a milder temperature and less heat is available in each radiator. Therefore, the heating effect in the room is milder than at high pressures. The difference between the heating effect of the given radiator at five pounds pressure and under ten inches of vacuum is equivalent to reducing the amount of radiation 22% when operating under



Dial of Illinois Vapor Gauge
Showing Pressures and Temperatures

the latter condition, which gives a mild, pleasant heat, yet there is no question of ample heating because the radiation is designed for extreme low temperatures, really emergency temperatures, so that the average demand on a heating system is only one-half of its maximum capacity.

In the latitude of New York and Denver, radiation is usually figured for or on the basis of 10° F. below zero outside, which is an emergency condition perhaps only occurring once during the winter for a few hours, while the mean average temperature throughout the heating season is above 30° F.

The mean average temperature for the past 51 years at Chicago, for November to March, inclusive, has been 31.1° F., while for the months October to April inclusive the mean average temperature has been 36.7° F.

Radiation is therefore figured for an emergency outside temperature of over 41° F. above the actual average outside temperature, and while this takes care of the pick-up load, that is, raises a cold room to desired temperature quickly, it also accounts for the unpleasant and unhealthful over-heating of buildings. Radiation is therefore 48.7% excessive for the average conditions, and any system which will permit the operation of the heating system at lower temperatures than the temperature of steam—and at the same time keep the radiators hot—gives a mild, pleasant heat, which is healthful and agreeable.

The Illinois Vapor System does this, and the above shows why this System operating at less than steam temperature, can still keep the building satisfactorily heated.

With ordinary heating systems it is necessary to have steam pressure before *any* heating effect is delivered to the building, hence in a short time the building is over-heated, and the fire allowed to die down, with the result that the heat in the boiler and boiler settings is allowed to cool off and waste—while with the Illinois Vapor System, in addition to not over-heating the building, the heat in the boiler and boiler settings down to perhaps 175° F. is utilized and delivered through the building. Hence the marked fuel saving of these Systems, as well as the advantage of modulated, comfortable heating.

The above shows why it is possible to satisfactorily heat with less than steam temperature—as the usual radiation is about 50 per cent excessive for average of operating conditions. It is also obvious that it takes less fuel to operate at these less than steam pressures.

It is a recognized fact that when raising steam pressure in a boiler by opening the drafts and burning coal rapidly the temperature, volume and speed of hot gases of combustion that pass through the smoke pipe or breeching and into the chimney are increased greatly. In fact, if the draft is strong, the smoke pipe may become red hot. Although steam pressure is raised quickly, it is obvious that there is a decided drop in operating efficiency, due to the abnormal heat carried into the chimney and wasted.

Conversely, it follows that if steam pressure is lowered by shutting drafts the operating efficiency is greater, as the boiler absorbs more heat from the slower moving gases of combustion. The fact that these gases have a much lower temperature and have given up most of their heat to the boiler is indicated by the cooler smoke pipe.

There is therefore considerable fuel economy secured by Illinois Vapor Systems normally operated with banked or slow fires, over systems wherein the boilers are fired to generate steam pressure.

STEAM TABLE

	GAUGE PRESSURE	ABSOLUTE PRESSURE	TEMP., F BOILING-POINT	LATENT HEAT	VOLUME 1 LB. STEAM
INCHES VACUUM	25	2.2	130	1017.4	157.1
	20	4.7	160	1001.	77.4
	19	5.2	164	998.7	70.6
	18	5.7	168	996.4	64.7
	17	6.2	172	994.4	59.4
	16	6.7	175	992.4	55.7
	15	7.2	178	990.6	52.3
	14	7.7	181	988.8	49.1
	13	8.2	184	987.2	46.2
	12	8.7	187	985.6	43.4
	11	9.2	190	984.1	40.8
	10	9.7	192	982.6	39.3
	9	10.2	194	981.2	37.8
	8	10.7	197	979.8	35.6
	7	11.2	199	978.4	34.2
	6	11.7	201	977.1	32.9
	5	12.2	203	976.0	31.7
	4	12.7	205	974.8	30.5
	3	13.2	207	973.7	29.3
	2	13.7	208	972.6	28.9
	1	14.2	210	971.3	27.8
	ZERO	**14.7**	**212**	**970.4**	**26.8**
POUNDS PRESSURE	1	15.7	215	968.4	25.1
	2	16.7	219	966.2	23.6
	3	17.7	221	964.3	22.5
	4	18.7	224	962.4	21.3
	5	19.7	227	960.5	20.5
	6	20.7	230	958.8	19.4
	7	21.7	232	957.2	18.7
	8	22.7	235	955.6	17.8
	9	23.7	237	954.0	17.1
	10	24.7	239	952.4	16.5
	15	29.7	250	945.5	13.8

Above covers possible range in Vapor Systems

A study of the Steam Table shows the corresponding temperature at which vapor or steam is generated at the various pressures above and below atmospheric pressure or zero gauge pressure also the latent heat of vaporization in British Thermal Units per pound of steam. The Table also shows the volume per pound of steam at the various pressures possible in a low pressure or vapor heating system. Thus it will be seen that with a heating system under 15 inches of vacuum we are circulating and heating the radiators with a vapor of 178° Fahr. sensible temperature, as against 212° Fahr. for atmospheric pressure. Also note that the latent heat of a pound of vapor at 15 inches of vacuum is 990 B.T.U., while the latent heat of a pound of steam at atmospheric pressure is only 970 B.T.U.

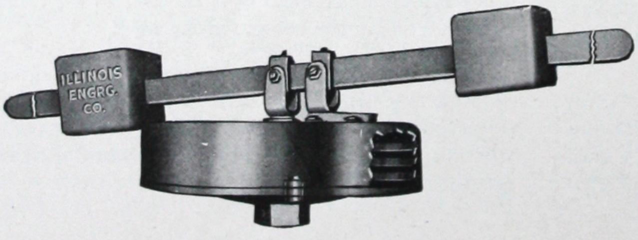
As the latent heat which is released upon condensation is the real heating agent, it will be seen that the vapor at the reduced pressures contains more useful heating effect than the steam at atmospheric pressure. Therefore there is no question as to the certainty of satisfactory heating at the reduced pressures of an Illinois Vapor System.

Also as the vapor has a considerable lower sensible temperature than even the steam at atmospheric pressure, it is apparent that the usual objectionable overheating is largely avoided in Illinois Vapor Systems. Overheating is perhaps the most undesirable feature of steam heating, with its attendant drying of the skin, mucous membrane and air passages of the occupants of the building.

It will also be noted that the volume (also the specific density) of steam increases as the pressure is reduced, the volume of a pound of vapor at 15 inches of vacuum being practically double the volume of a pound of steam at zero pressure. This partially explains the rapidity of circulation of vapor, which is marked in our vapor systems. The Vapor under vacuum circulates as positively, and more rapidly than steam at low pressures, so that a radiator which has been shut off and is cold will heat up at once upon opening the radiator supply valve. The attached Steam Table shows why the results which our Systems give are based on thermodynamic principles.

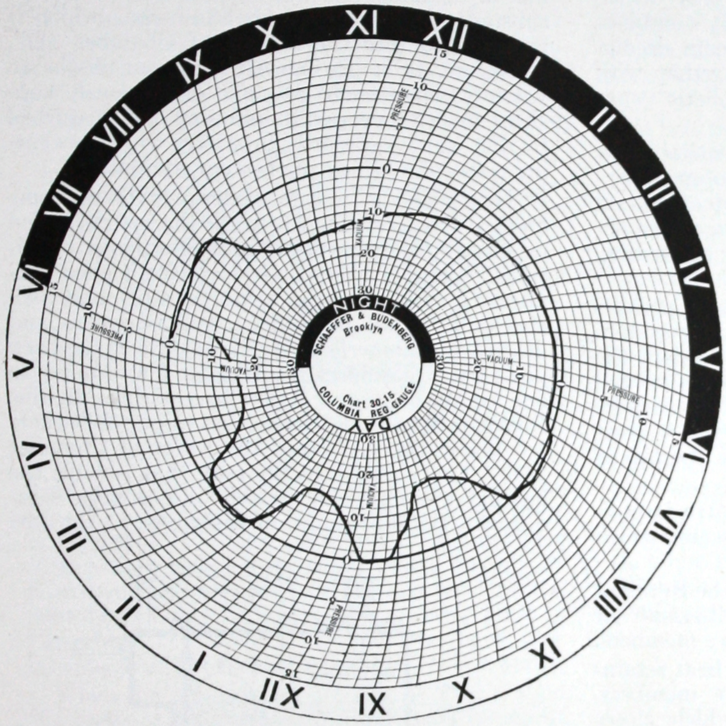
Illinois Damper Regulator

All Illinois Vapor Systems have our Vapor Damper Regulator installed to control boiler pressure under ordinary operating conditions. The operative element is made up of a series of phosphor bronze diaphragms of large diameter, which, together with the long lever, make the regulator unusually sensitive and powerful. These regulators will work on vapor pressures, and are readily adjustable to operate the boiler at any pressure up to 8 pounds.



The Illinois Vapor Damper Regulator is installed in the usual manner, with the draft door and check damper of boiler connected to the ends of the lever, and the double weights give accurate counter-balancing and adjustment for desired pressure.

Proof That Illinois Vapor Systems Operate on Vapor Pressures



Twenty-Four-Hour Recording Pressure Chart
Graymore Court Apartments, Newark

Analysis of Chart and Its Story

A Recording Compound Pressure and Vacuum Gauge accurately and automatically registers the pressure conditions on a Heating System. The Roman numerals on the outer circle indicate the hour, day and night, and the radial lines divide the hours into 15-minute intervals.

The circles indicate pressure and vacuum, the heavy circle indicates zero pressure, the circles within the zero circle each indicate two inches of vacuum, and the circles outside the zero circle indicate one pound of pressure each. The heavy irregular line shows the pressure or vacuum on the System at any hour.

A study of the chart herewith shows that it was put on at 6 P. M., at which time, and for the next hour and a half, the pressure was slightly below atmospheric pressure, averaging one inch of vacuum. At 7:30 P. M. the boilers were fired, and steam (½ lb. maximum) was carried until 8:15 P. M. at which time the fires were banked for the night, and the job quickly went under vapor conditions, 14 inches of vacuum being recorded at 9:45 P. M. It was not necessary to again fire the boilers until 7:00 A. M. as the heat retained in the System kept the building satisfactorily heated for nearly eleven hours. Steam was carried for an hour and a half, reaching nearly one pound at 8:00 A. M.

The fires were then banked and at 8:30 A. M. the System went under vapor conditions reaching 15 inches of vacuum at 10:00 A. M. Twice through the day steam was raised at about atmospheric pressure for short periods—probably by shaking down the fires—the System quickly going under vapor conditions between these periods, down to 16 inches of vacuum, and at the end of the 24-hour period there was 10 inches of vacuum on the job.

These Facts Are Apparent

That during nearly 20 hours of the 24, the Heating System operated under vapor conditions and that the boilers were only fired or given attention 4 times in the 24 hours.

That the building was satisfactorily heated at all times will be conceded in view of the fact that the building is a high class apartment, and tenants of such buildings are naturally exacting in their requirements.

The *Fuel Economy* effected by this System over other Systems which require actual steam pressure to heat the building, will conservatively run from 20 to 33⅓ per cent—this in addition to refinements in operation not equalled by other methods of steam heating.

Illinois Heat Retainor

Browne Patent

The Illinois Heat Retainor is the only device of any description which permanently combines successfully vacuum circulation, or steam circulation below atmospheric pressure, together with all the advantages of an open atmospheric vapor system.

The Illinois Heat Retainor is an entirely new operating principle and is a development exclusively our own. It is the product of several years of experimentation and a large number have been in successful operation for six heating seasons.

The Illinois Heat Retainor, not only permits the free escape of air from the heating system with no appreciable resistance and renders the return of air impossible, but its construction and operation is such that it cannot be affected by dirt, rust or scale, as the air is water-washed before reaching the valve, which is in the top of the tank.

Furthermore, the closing of the valve is positively actuated by a 19-pound pressure, which insures tight seating.

Referring to Cross Section Cuts of the Retainor herewith, Figure 1 illustrates the normal air venting position of the float and valve members.

Figure 2 illustrates the vacuum or heat retaining position of the float and valve members, showing the remarkable pressure which closes the valve at all pressures and that the closing pressure is independent of the vacuum or pressure.

Figure 3 illustrates the equalizing position of float and valve members when considerable boiler pressure is carried.

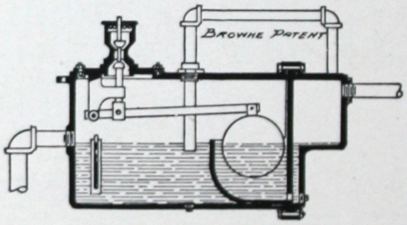
Operating Description

Air Venting Function

Air from Heating System at point "A" which connects to the terminal of the dry air return at the point where it drops wet; passes from "A" through pipe "B" into Chamber "D" and thence out through valve members (1) and (2). It will be noted that valve members are wide open and offer no resistance to the passage of air through them in quantities up to the maximum capacity of valve members. Size ¾" lifts ¼".

It is apparent that air in venting through brass pipe "B" terminating ½" below water line in Chamber "D" is washed of solid foreign substances, pipe scale, core sand, etc., which is precipitated into the bottom of Chamber "D". Therefore, it is obvious that the air discharge valve (1) is automatically and continuously kept clean and its proper functioning not disturbed by dirt which ordinarily interferes with the venting point of any heating system equipment.

Necessarily a closed system involves some method that permanently keeps the system sealed or closed from surrounding atmospheric conditions. Vertical check valves, spring loaded diaphragm check valves, mercury seals and ball checks have all been tried in past years and discarded as imperfect. In those devices the back pressure is considerable, from a few ounces to one pound or more. It is also variable. In this Retainor it will be noted that pipe "B" vents ½" below the surface of the water in Chamber "D". This constitutes the seal, that isolates the heating system from outside atmospheric conditions. Back pressure, or resistance to the free



NEUTRAL OR AIR VENTING POSITION— VALVES OPEN.

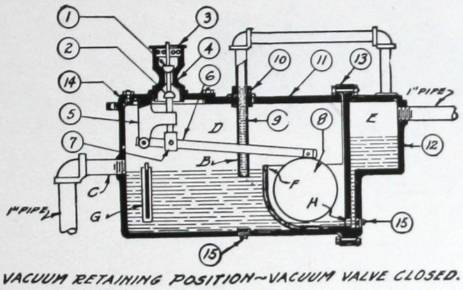
Figure 1

venting of air is reduced to practically nothing. It is less than 1-50th of a pound or a fraction of an ounce. This condition is definitely constant and is not subject to mechanical variations. It does not vary with the quantity of air being expelled. It is a constant resistance regardless of slow or rapid circulation. Pipe "C" is the overflow connection which maintains a constant water level under venting conditions.

Vacuum Function

When the condensing rate of the radiators is greater than the evaporating rate of the boiler plant, then the pressure drops, and when it falls below atmospheric pressure and a partial vacuum

exists within the system, air pressure exerted upon the surface of the water in Chamber "D" causes, in accordance with the pressure, a column of water to rise in pipe "B" and in Chamber "E." The maximum quantity of water in pipe "B" is insufficient to lower appreciably the water line in Chamber "D"; thus, it is impossible to break the seal. The water rising simultaneously in Chamber "E," due to atmospheric pressure, lowers float (8). The amount of water in the



VACUUM RETAINING POSITION—VACUUM VALVE CLOSED.
Figure 2

float bowl is small in relationship with the capacity of Chamber "E," therefore a rise of 1" in Chamber "E" causes a fall of 2" in the water in the float bowl. The water passes out of the float bowl through port "H." The sides of the float bowl being higher than the water level in Chamber "D," there is therefore no back flow into the float bowl when its water level is lowered.

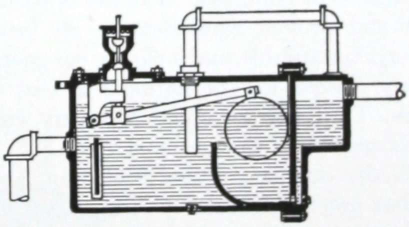
When the atmospheric pressure is greater than the pressure within the heating system, by about four ounces; or, in other words, there is about ½" of vacuum within the heating system, all water has left the float bowl as indicated by the accompanying Figure 2. This leaves the float suspended. The weight of this float acting through float arm lever (6) exerts a closing pressure upon Vacuum Valve (1) equivalent to over 19 lbs. per square inch of area. Valve members are machined very carefully and ground in oil, to an absolutely air-tight condition. The application of this unusual pressure at so small a differential between pressure conditions within and without the system of heating (nineteen pounds per square inch, valve closing pressure at ½" of vacuum) is the secret of the success of this device in preventing the leakages of air back into the heating system, which has previously been expelled under pressure conditions as heretofore explained.

It should be kept in mind that at any vacuum less than ½" it is impossible for air to leak back through this device as it is obvious that port "H" is water sealed until all water is withdrawn and full pressure applied to Vacuum Valve, as described. The height of pipe "B" being greater than the column of water in Chamber "D," it is therefore impossible for the seal to break at this point.

Pressure Function

When the boiler pressure is sufficient to cause condensation to rise and flood the Retainor through overflow connection "C," the float rises accordingly and closes Pressure Valve (2) through lever action as previously described. The accompanying Figure 3 illustrates the maximum closing pressure of valve (2), or height of water in Retainor. Valve (2) actually closes when the water lever is 2" below that indicated. Therefore, it is apparent that an equalizing pressure in the dry return line is created long before there is any tendency to flood the dry return through inlet connection "A." This feature is highly important.

Briefly expressed, this device is unqualifiedly guaranteed to perform the three functions attributed to it, exactly as heretofore described. It is especially guaranteed to prevent the return of air that has been expelled. It is sold strictly upon this basis. It is not guaranteed, however, to return condensation rapidly and in a positive manner

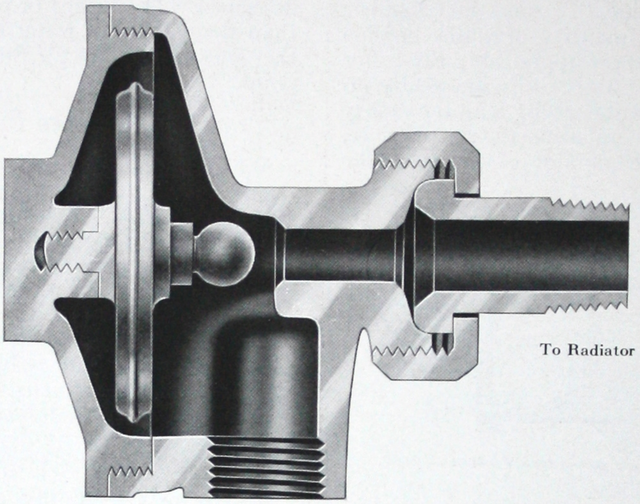


PRESSURE OR EQUALIZING POSITION—CONDENSATION RETURN VALVE CLOSED.
Figure 3

in large heating systems. For a full explanation of this, refer to description "A" type System, Page 16.

In view of the three functions performed by this Retainor, it is noteworthy that the mechanical operation is of the utmost simplicity. Simply a float and lever, connected to a Compound valve member. The float moves slowly up or down according to pressure or vacuum, two and one-half inches from the neutral position, that's all.

Illinois Thermo Radiator Trap



The Thermo Trap is the product of 25 years of experiment and development by specialists in vapor and vacuum heating. Its success and durability are amply proven by years of service in thousands of buildings. The use of such time-tested and proven equipment is an insurance policy against trouble, and it carries our guarantee.

Many reasons for the national success of the Thermo Trap will be noted by every engineer upon inspection of the sectional view.

It is the original vertical seat trap, and the fact that practically all traps put on the market in recent years follow this design is proof of its merit.

The diaphragms are of a special 90,000-pound tensile strength phosphor bronze, rolled to our specifications. The diaphragms are milled and adjusted by our patented process, so that they, as well as all parts of the trap, are absolutely interchangeable. Not only are these traps non-adjustable—being factory adjusted and steam tested—but any diaphragm will work in any valve body without adjustment. These traps are, therefore, both interchangeable and non-adjustable.

The Thermo Traps are noiseless, making them the ideal equipment in hospitals, hotels and apartments. They are automatic and positive in operation, the valve being open to permit passage of water and air; but diaphragm expanding to close the valve as soon as steam reaches it. They are absolutely steam-tight on all pressures without adjustment of any kind. They automatically prevent waste of steam from the radiator. Note the following points of superiority:

The Vertical Seat

Dirt does not lodge and lie on it, as on a horizontal seat at bottom of valve body. Result—Does not easily foul and stop up.

Diaphragm Closes Against the Steam

—not in the steam. Result—Accurate and sensitive operation; does not have to wait until water condenses in radiator and cools off before opening; gives higher radiator efficiency.

Concave Diaphragm

Concave sides give flexibility without strain on diaphragm, like the spring in the bottom of an oil can.

Ball and Cone Seat

Will always seat. Best type of seat known; used on extra high pressure Admiralty Traps.

The Illinois Thermo Traps are completely manufactured in our own plant—from casting to finished trap—the bodies of steam brass—*not cast iron*—machined by box tools to test gauges. *No cover gaskets*, but metal to metal joints, insuring permanent accuracy of adjustment.

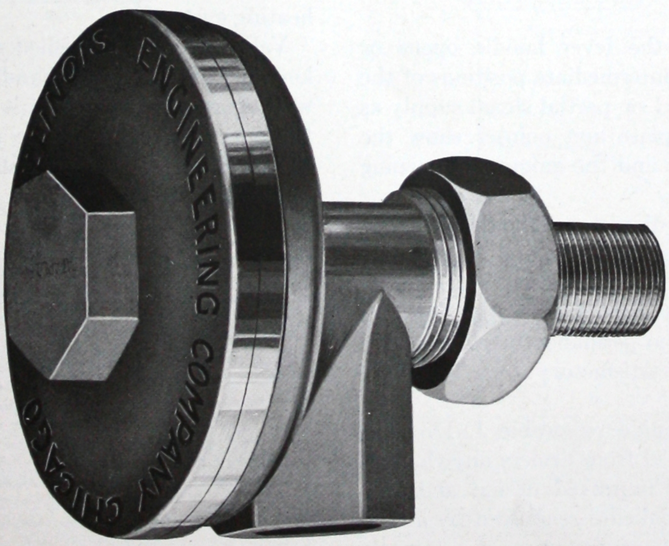
The *Lock Nuts* are malleable iron to insure strength.

The diaphragms are strong enough to operate against 50 lb. steam pressure. This not only insures durability, but protects against damage if pressure on the Heating System runs up, as often occurs.

Test any Trap you are considering under 20-50 lbs. pressure—be guided by the result. Illinois Thermos have a factor of safety to withstand these pressures.

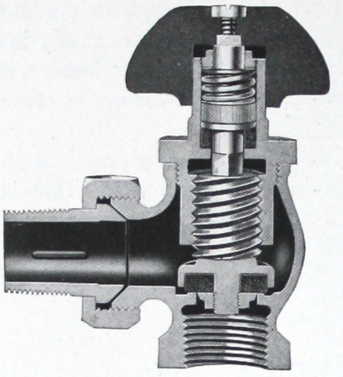
Sizes and Dimensions

SIZE	Pipe Connections	WEIGHT	Center Outlet to end of spud	Center Spud to Face of Outlet
No. 1—½″	½″	2½ lbs.	2½″	1¾″
No. 2—½″	½″	3 "	2½″	1¾″
No. 3—¾″	¾″	4 "	2¾″	2 7/16″

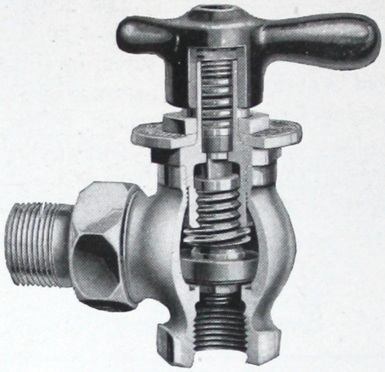


Illinois Modulating Valve

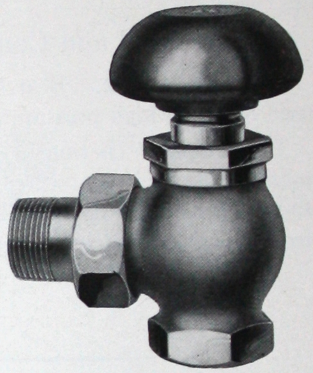
Packless—Graduated



Mushroom Hand Wheel



Bakelite Lever Handle



Mushroom Hand Wheel

The Illinois Modulating Valve is the ideal steam radiator supply valve. They are heavy and made of the best steam brass, cast from plated patterns in our own brass foundry, and accurately machined with box tools in our own factory, so that all parts are interchangeable. The bodies are full nickeled, with polished trimmings.

One-half turn of the lever handle opens or closes the valve and intermediate positions of the handle give fractional or partial steam supply as wanted. The dial plate and pointer show the position of the valve and the amount of opening of same.

Owing to the large diameter of the thread spool, these valves operate very easily, and require only a half turn from full open to closed positions.

The Illinois Valves are packless—do not require packing—being of the permanently packed type which has proven satisfactory over years of service.

The discs are genuine renewable J. D. discs, which can be obtained from dealers anywhere.

The handle is of improved design and construction, being of Bakelite reinforced by a steel plate insert which gives unusual strength. Bakelite is a non-conductor, and as it covers the top of the valve completely, it protects the hand of the operator from burning.

These valves close tight and remain tight against any steam pressure.

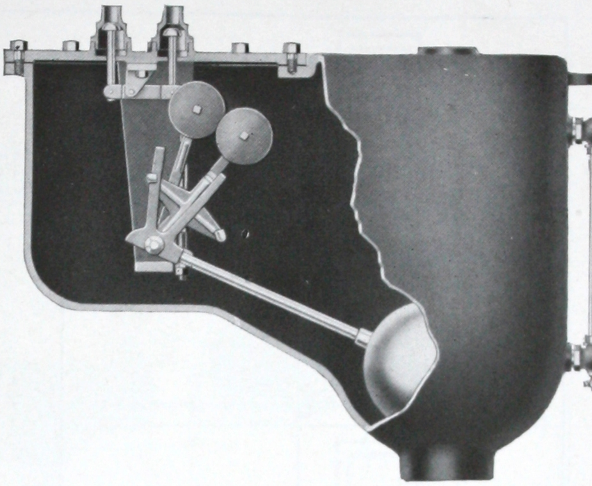
These Illinois Valves give complete satisfacion on any type of radiation and in any type of steam heating system.

Valves are also furnished with Lock Shield and key in place of lever handle for use in public waiting rooms and where it is desirable to have the operation of the valve under the control of the engineer. Also furnished with mushroom handle wheel.

Sizes and Dimensions

SIZE	C. Inlet to Face	C. Tailpiece to Face	Wt. Lbs.
¾″	2⅝″	1⅜″	2
1″	3⅛″	1 9/16″	2¾
1¼″	3½″	1¾″	4½
1½″	4″	2″	5
2″	4½″	2⅜″	7½

Illinois Return Trap

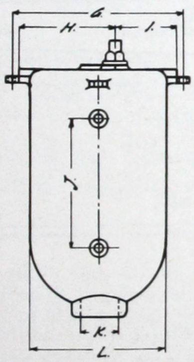


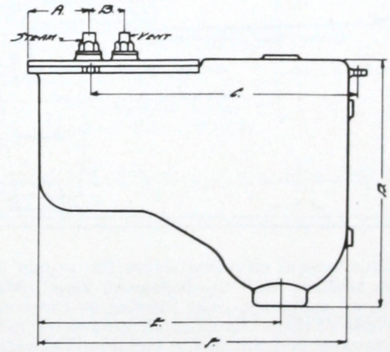
A vitally necessary part of every successful vapor heating system. The Illinois Return Trap automatically returns the condensation to the boiler, regardless of the pressure on the boiler up to 8 pounds, at the same time discharging the air. This trap embodies the improvements and refinements suggested by over 15 years of operation. Its installation insures positive and complete circulation, the sure return of condensation to the boiler, and prevents cracked boiler sections.

When the boiler pressure is such that water does not return by gravity, the water fills the trap, lifting the float which operates the weight and lever mechanism, which positively opens the steam valve, admitting boiler pressure to the trap, thus equalizing boiler pressure so that the water flows to boiler. At the same time the air vent valve is closed so steam cannot blow into the returns. When the trap discharges the water, the float falls, reversing the valve operation, so that the air vent valve is open to vent air.

The trap is self-contained, with no external working parts to be misadjusted, tampered with or injured.

There are no stuffing boxes or packed joints, which insures continuous tightness against air or water leakage. The Original Return Trap employing these features.

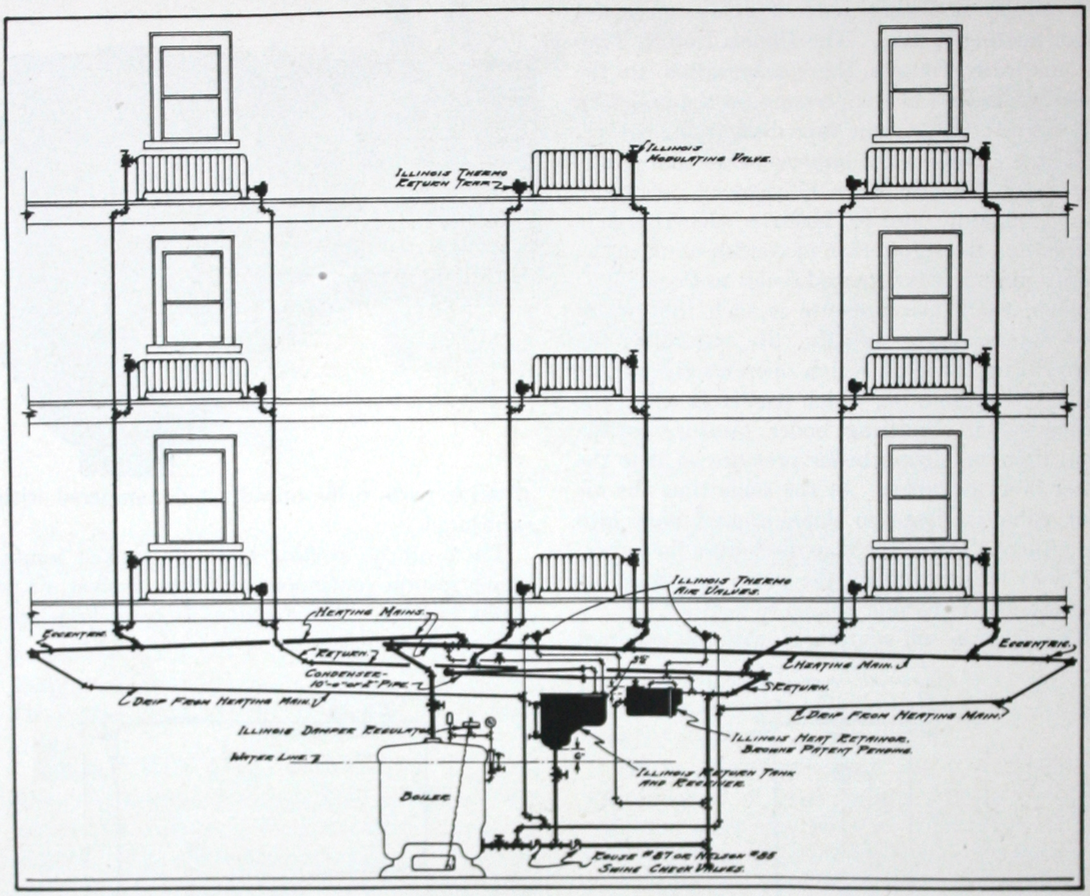




Sizes, Capacities, Dimensions

No.	Capacity Sq. Ft. of Dir. Radiation	Dimensions Inches												Shipping Weight
		A	B	C	D	E	F	G	H	I	J	K	L	
00	1500	3¼	2 1/16	....	13½	10¾	14⅜	10⅜	5½	4	7⅜	1½	5⅞	95 Lb.
0	2500	5	3¼	17½	15¼	16¼	20	14	7½	5¼	7½	2	7¾	140 Lb.
1	5000	5⅝	3¼	23¼	22⅞	22¼	27	15¾	8¾	5¾	12	2½	9½	305 Lb.
2	8000	5⅝	3¼	24⅞	22⅞	22⅜	28¾	15¾	8¾	5¾	12	3	12¾	330 Lb.

Typical Elevation—Type A System



The above typical elevation shows the supply and return risers starting from the basement loop mains and running to all radiators. The laterals or run-outs from mains to base of risers should pitch toward the mains, to avoid all pockets or traps in the piping. Hot water type radiation is preferred, which places the Modulating Supply Valve at top of radiator, where accessible without stooping over.

In general the piping follows the best practice for steam heating installations.

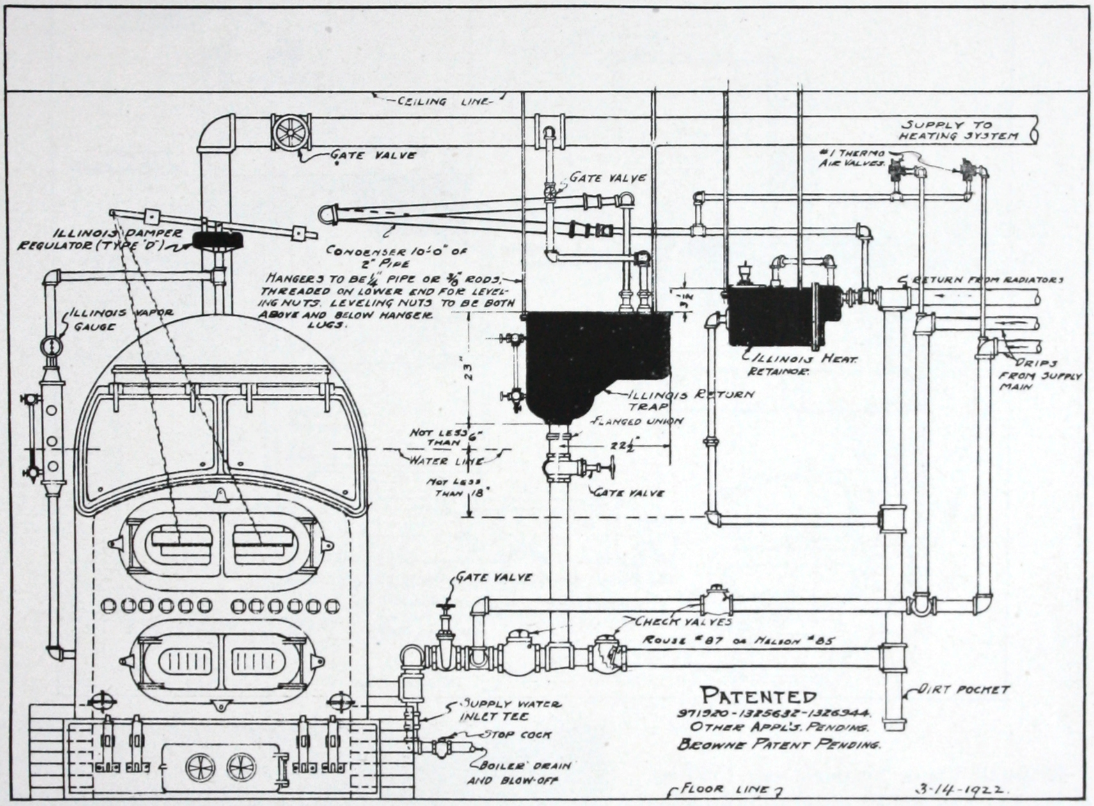
In large buildings, or where there is automatic temperature control, the A Type System is preferable. Operation of the Return Trap is described on Page 17. The Illinois Heat Retainor sets slightly higher than Return Trap, which sets lower than the return main, so that these units operate before the horizontal dry return is flooded.

The Return Trap provides quick equalization of boiler pressure and immediate return of water to the boiler. The Heat Retainor will also in time return the water by indirect equalization of pressure. The positive return of water to the boiler is doubly assured by the *Illinois System*, which is another exclusive feature of this System.

It definitely assures steady boiler water line conditions and continuous return of condensation under normal or abnormal conditions without the loss or expulsion of any water, to a far greater extent than has heretofore been possible by any other method.

When there is not sufficient boiler pressure to raise condensation to top operating point of return trap, usually 1 lb. or less, then the condensation will return to boiler by gravity, without bringing into operation the return functions of either the Return Trap or the Heat Retainor. The amount of time that sufficient pressure would be carried to operate the return function of either or both devices during the course of a heating season, is relatively very small. This is a very important and exclusive feature of the *Illinois System* as it provides extreme durability.

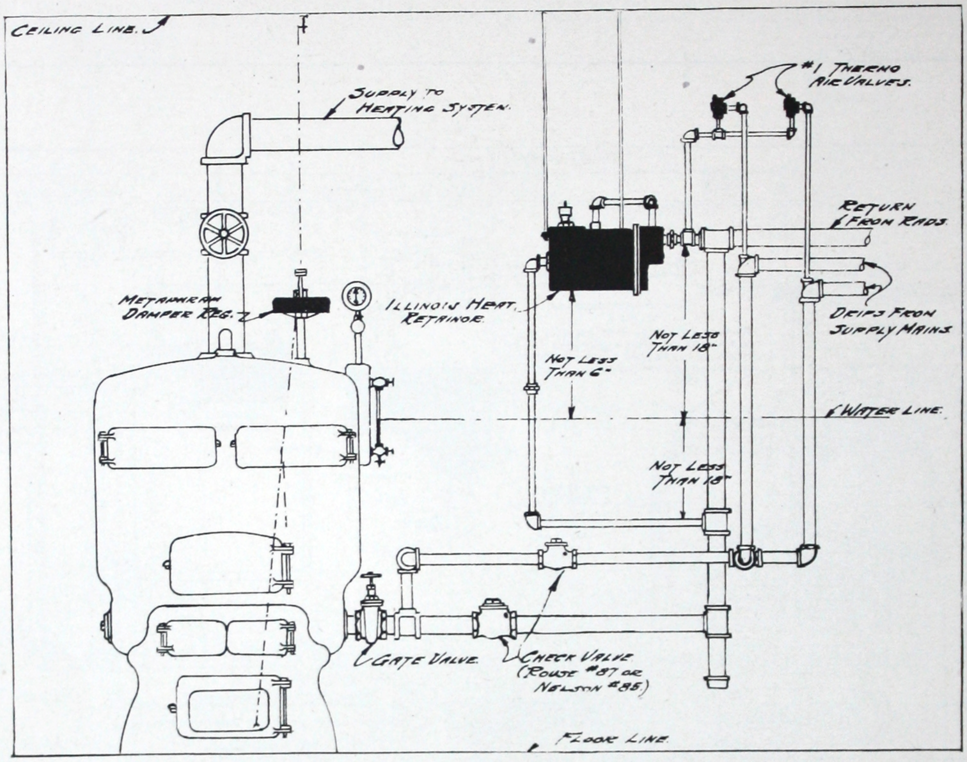
Typical Boiler Room Assembly



The above shows the general arrangement of piping for the proper installation of the automatic appliances. The drips from the ends of supply loops are brought direct to boiler feed pipe inside of the check valve. The return main is run to boiler feed pipe, as shown, with the Illinois Return Trap installed on a standpipe connection between two check valves, as shown. Place Illinois Return Trap as high as bottom of return main. Usually sufficient head can be had so that condensation will pass into boiler by gravity when boiler pressure is less than one pound. When boiler pressure is higher than the pressure due to head, the large check valve closes, and the condensation rises into the Return Trap, which then operates as described on page 17. The small check valve prevents pressure from backing up into the return. The entire operation is automatic and positive.

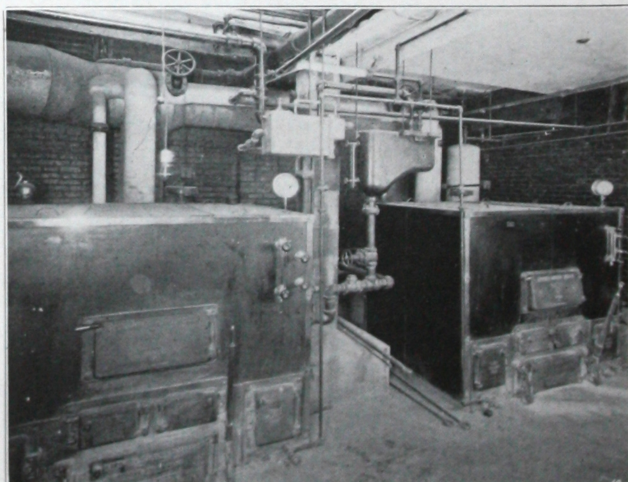
The Illinois Heat Retainor is set 3½" above the Return Trap and these devices operate to prevent the return from radiators from becoming flooded, thus allowing constant air elimination from the System.

Type B System—Residential



In small Vapor Systems, say 1500 sq. ft. or less, the slower equalizing function of the Heat Retainor will operate to put the water back in the boiler against pressure, before the retention of the water in the System will endanger the boiler. For this reason the Return Trap is sometimes omitted from the smaller installations, and the layout above shown is used.

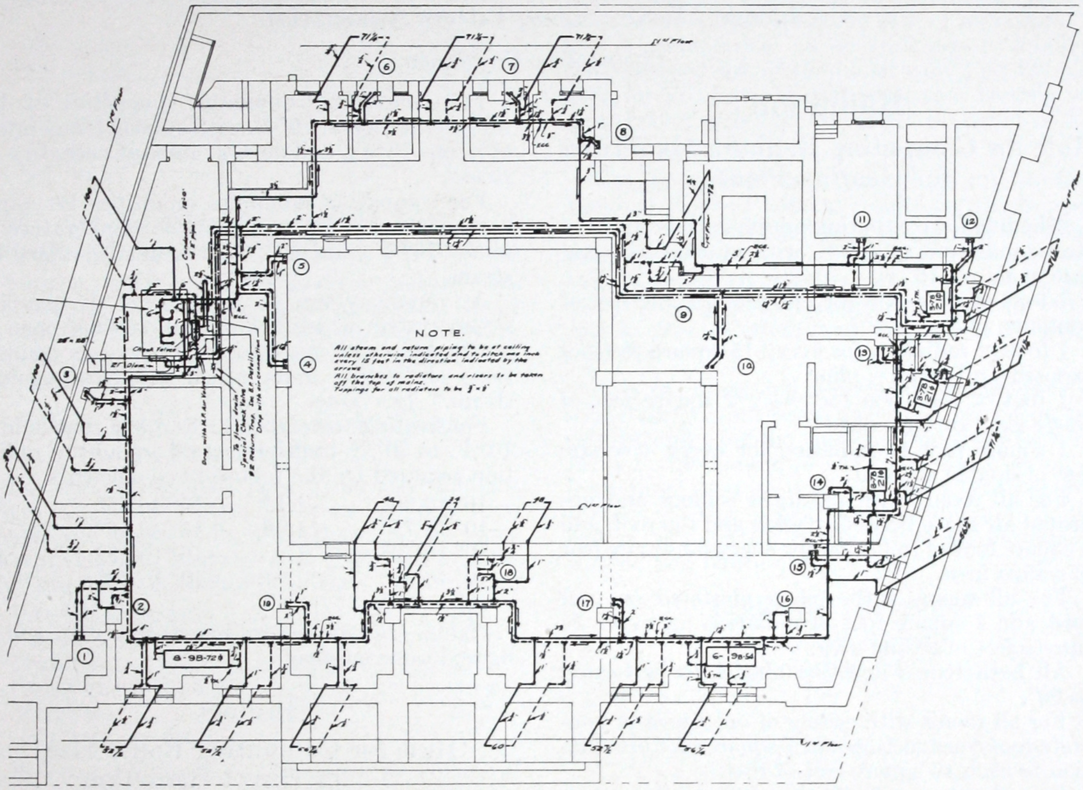
If the boiler pressure should rise accidentally or otherwise, the broad operating range provided by the *Heat Retainor* would prevent any decided drop in the water line of the Boiler, which is a distinct safety feature.



Boiler Room Installation—Type A

Basement Piping Plan

International Banking Corporation, Hankow, China



The above basement layout shows the general piping arrangement for an Illinois Vapor System. Leaving the boiler header, supply mains and branches extend around the building to supply the up-risers feeding the radiators, the basement supply should pitch in direction of flow. The boiler connections should be full size of boiler openings, to avoid water lifting over into header, and the header should have an equalizing pipe to feed opening of boiler. Keep supply loop up as close to ceiling as possible. From the far end of supply loop mains a wet or dry drip return is run directly back to feed opening of boiler.

A return main loop is run parallel to the supply loop to carry the air and water of condensation from the radiators. This is connected to the feed opening of boiler, as shown on page 8.

No supply main to be less than 2-inch, no return main less than 1¼-inch; ½-inch pipe not recommended, because it stops up in elbows.

Drip main from end of each supply main to be two sizes smaller than the smallest size of the supply main.

All mains to pitch at least 1 inch in 15 feet in the direction of flow.

All branches from mains to risers to pitch one-half inch to the foot toward the main. Avoid all pockets in piping.

Branches from mains or risers to radiators to be one size larger than valves.

Make all radiator connections flexible to provide for expansion and contraction.

Pitch piping from radiator to riser to avoid pockets.

Note—*The radiation on the four upper floors of above building are shown on a separate Riser Diagram. Photo on inside of front cover.*

Standards for Computing Radiation and Boiler Sizes

Compiled by the Standardization Committee of the

Chicago Master Steam Fitters Association

Published by Permission

Radiation

Rule for Computing Radiator Quantities for Heating Plants

Schedule for computing minimum quantities or steam radiation at 70° F. with outside temperature at minus 10° F.

1 foot of radiation for every 300 cubic feet of contents, plus

1 foot of radiation for every 15 square feet net exposed wall surface, plus

1 foot of radiation for every 2 square feet of single glass surface, plus

1 square foot of radiation for every 4 square feet of double skylight.

For all rooms with plastered ceilings and unheated air space between ceiling and the roof, add 1 square foot of radiation for every 30 square feet of ceiling area.

For all rooms with ceiling plastered on roof joist add 1 square foot of radiation for every 20 square feet of ceiling area.

All bath rooms in living abodes to be heated to 80°.

For all rooms with ceiling of open joist or concrete roof construction add 1 square foot of radiation to each 10 square feet of roof.

For all rooms with northeast or northwest exposures add 10% additional radiation.

Where radiators are placed under seats or behind grills add 20% additional radiation.

Where radiators are placed in open recesses add 10% additional radiation.

For indirect radiation without fan system add 50% additional radiation.

For direct-indirect without fan system add 25% additional radiation.

Where single pipe coils or single cast-iron wall radiation is placed on side walls 80% of the required amount of standard column radiation may be installed. Size of boiler and piping, however shall be based on standard column radiation requirements. Ceiling coils to be considered as standard column radiation.

In measuring glass surface the full opening in wall shall be figured. Outside door openings shall be taken as glass.

For computing minimum quantities of hot water radiation at 70° F. with outside temperature at minus 10° F., add 60% to amount necessary for steam.

For computing minimum quantities for vapor systems at 70° F., with outside temperature at minus 10° F., add 20% to amount necessary for steam.

A vapor system is defined as a two-pipe steam system which has the return lines open to atmosphere with no valve at the return connections of heating units which will close against steam.* See Note.

For heating to temperatures other than minus 10° F. to 70° F. multiply actual amount of radiation required by the following co-efficients:

—10° to 80°.....	1.13	—10° to 55°.....	.81
—10° to 75°.....	1.06	—10° to 50°.....	.75
—10° to 70°.....	1.	—10° to 45°.....	.69
—10° to 65°.....	.94	—10° to 40°.....	.62
—10° to 60°.....	.87		

*Note—*Illinois System* has these valves and is figured same as steam.

Boilers

Rule for Computing Boiler Sizes for Direct Radiation

Schedule for computing minimum sizes of boilers for the average building based on approved ratings specified in the manufacturer's catalogue.

First reduce all radiation to the equivalent of cast iron column radiation, then add the following factors of safety when buildings are heated from —10° to 70°.

Round Cast iron up-draft boilers. add	80%-180%
SquareCast irondown-draftboilersadd	60%- 90%
Sq. Cast iron, Smokeless Boilers. add	50%- 70%
Steel firebox boilers............add	25%- 45%
Steel firebox smokeless boilers...add	20%- 45%

Steel firebox up-draft boilers with approved furnace to be figured on same basis as steel smokeless of similar number.

Steel tubular or steel water tube boilers 100 sq. ft. per horse power (A. S. M. E. code).

In computing boiler sizes for buildings heated to lower than—10° to 70° F. multiply the amount

of cast iron column radiation necessary to maintain the required temperature by the following co-efficient before adding the percentage given in rule for computing boiler sizes:

	Steam	Water
—10° to 65°	1.03	1.05
—10° to 60°	1.07	1.09
—10° to 55°	1.10	1.13
—10° to 50°	1.13	1.18
—10° to 45°	1.17	1.24
—10° to 40°	1.20	1.27

Rule for Computing Boiler Sizes for Direct-Indirect and Indirect Radiation

For computing boiler size for direct-indirect and indirect radiation, reduce same to basis of direct by adding 25% to direct-indirect and 50% to indirect, then use factor of safety as called for on direct radiation.

Rule for Computing Boiler Sizes for Hot Blast Coils

For computing boiler size to be used for Hot Blast Coils use manufacturers' condensation charts and figure ¼ lb. of condensation per hour as equivalent to 1 square foot of direct radiation and add following factor of safety:

Fire-box, up-draft	10%
Fire-box, down-draft	15%
Portable	15%
Cast-iron, down-draft	25%
Magazine	25%
Cast-iron, up-draft	40%

Where coils are to be inserted in boiler, or steam coils in hot water tank for heating water for domestic purposes, size of boiler should be increased, figuring each gallon of water-tank capacity as equivalent to 2 square feet of radiation. For example, a 160-gallon tank should be figured as equivalent to 320 square feet of radiation. If this is connected to an up-draft cast-iron boiler, the increased size of the boiler would be 320 plus 80%, or 576 feet. If connected to a fire-box up-draft boiler, increased size of boiler should be 320 plus 35%, or 432 feet.

The above schedules of quantities are commensurate with good heating results for the average building of average construction, but by no means to be construed as guarantees of the proper quantities of radiation or boiler sizes necessary to heat every building, as extraordinary conditions will of course require additional radiation or boiler capacity.

It is recommended that in all installations of steam boilers that drain valves be placed on the returns and that the condensation from such returns be discharged in the sewer for a period of from three days to one week after starting fire, thereby clearing system of grease and dirt. At the end of this period, boiler should be thoroughly washed and blown out.

Radiator Tappings

Supply and Return

¾″ x ½″ up to 100 sq. ft. Radiation.
1″ x ½″ " " 200 " " "
1¼″ x ¾″ " " 300 " " "
1½″ x ¾″ " " 500 " " "
2″ x ¾″ " " 750 " " "
or equivalent of indirect.

Pipe Sizes

MAINS			RISERS			Horizontal Supply Branches Mains to Risers		Horizontal Return Branches Mains to Risers	
Supply	Maximum Radiation	Return	Supply	Maximum Radiation	Return	Supply	Radiation	Return	Radiation
2″	400 sq. ft.	1¼″	¾″	40 sq. ft.	¾″	¾″	20 sq. ft.	¾″	60 sq. ft.
2½″	700 " "	1½″	1″	80 " "	¾″	1″	60 " "	1″	350 " "
3″	1,250 " "	1½″	1¼″	150 " "	1″	1¼″	110 " "	1¼″	1,700 " "
3½″	2,000 " "	1½″	1½″	220 " "	1″	1½″	160 " "		
4″	3,000 " "	2″	2″	500 " "	1″	2″	400 " "		
4½″	4,300 " "	2½″	2½″	900 " "	1¼″	2½″	700 " "		
5″	5,600 " "	2½″	3″	1,500 " "	1¼″	3″	1,100 " "		
6″	9,000 " "	3″	3½″	2,100 " "	1¼″	3½″	1,800 " "		
7″	14,000 " "	3½″							
8″	19,000 " "	4″							

74 So. Munn Avenue
East Orange, N. J.

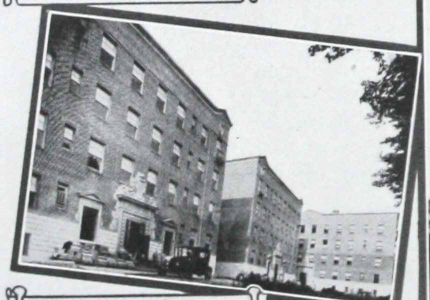
Co-operative Apartments
Boston

Knights of Columbus Club
Memphis

Carolan Hotel
Chicago

Max & Wm. Bloom Apartments
Williamsport, Penna.

Harper Apartments
Wichita



10-34 Kearney Street
Newark

444 Belmont Avenue
Chicago

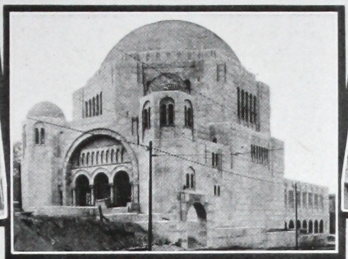
Altshuler Cohen Apartment
East Orange, N. J.

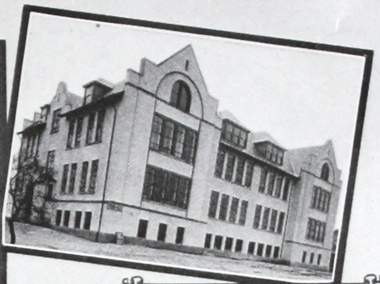
Littel Building
Buffalo

Pacific Telephone & Telegraph Co.
Modesto, Calif.

Hotel Monticello
Longview, Wash.


Commercial Casualty Ins. Co.
Newark


Temple Tilferth
Cleveland


St. Stanislaus Orphan Home
Nanticoke, Penna.


St. Joe Valley Bank
Elkhart, Ind.


114 East 90th Street
New York City


Chevrolet Garage
Muskegon, Mich.


New National Theatre
Richmond, Va.


Commonwealth Building
Harrisburg, Penna.


First National Bank
Berwyn, Ill.


Pacific Tel. & Tel. Co.
San Francisco


Nurse's Home
Rochester


S. S. Kresge Company
Cleveland

ILLINOIS · HEATING · SYSTEMS ·


Public School No. 1
West New York, N. J.

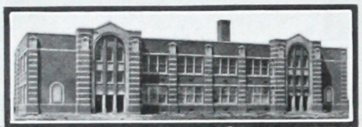

Kingsman School
Washington


Pacific Heights School
San Francisco


William G. Crosby High School
Belfast, Maine


School Building
St. Louis


Roosevelt School
Elkhart, Ind.


Roosevelt School
St. Paul


Masonic Club & Lodge Bldg.
Newark


Leland Stanford School
Sacramento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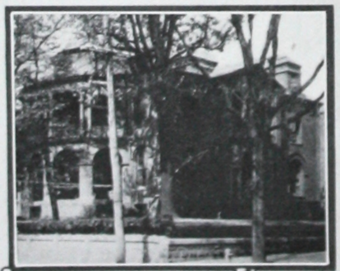
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